

CLAIMS:

1. A membrane module including a plurality of porous membranes extending in an array and mounted, at least at one end, in a header, said header having a number of
5 distribution apertures for distributing a fluid into said module and along a surface or surfaces of said membranes, a chamber having one open end and another end in fluid communication with said distribution apertures for distributing said fluid to said distribution apertures.
- 2 A membrane module according to claim 1 wherein the chamber is elongate
- 10 3. A membrane module according to claims 1 or claim 2 wherein the length of said chamber is greater than that required to provide a static head, when the membrane is immersed in a liquid and gas introduced into the chamber, equivalent to the head loss for the gas to flow to said distribution apertures.
4. A membrane module according to any one of the preceding claims wherein the
15 fluid is gas.
5. A membrane module according to any one of claims 1 to 3 wherein the fluid is a mixture of gas and liquid.
6. A membrane module any one of the preceding claims wherein the chamber is enclosed on all sides.
- 20 7. A membrane module according to any one of preceding claims wherein the header or headers are mounted in a clover shaped manifold.
8. A membrane module according to any one of claims 1 to 6 wherein the header or headers are mounted in a linear, rectangular, square, or hexagonal manifold.

9. A membrane module according to any one of the preceding claims wherein the chamber has a plurality of sides positioned to form a skirt directly beneath a header or plurality of headers.
10. An array of membrane modules according to any one of the preceding claims when
5 arranged in the form of an extended linear array wherein the chamber has enclosed long sides.
11. An array of membrane modules according to claim 10 in the form of an extended linear array wherein the chamber has unenclosed short sides.
12. An assembly of membrane modules including a plurality of porous membranes
10 extending in an array and mounted, at least at one end, in a plurality of respective headers, said headers being configured to provide a number of distribution apertures therebetween for distributing a fluid into said assembly of membrane modules and along a surface or surfaces of said membranes, a chamber having one open end and another end in fluid communication with said distribution apertures for distributing said fluid to said
15 distribution apertures.
13. An assembly of membrane modules according to claim 12 wherein the chamber is elongate.
14. An assembly of membrane modules according to claim 12 or claim 13 wherein the length of said chamber is greater than that required to provide a static head, when the
20 membrane is immersed in a liquid and gas introduced into the chamber, equivalent to the head loss for the gas to flow to said distribution apertures.
15. An assembly of membrane modules according to any one of claims 12 to 14 wherein the fluid is gas.
16. An assembly of membrane modules according to any one of claims 12 to 15
25 wherein the fluid is a mixture of gas and liquid.

17. An assembly of membrane modules any one of claims 12 to 16 wherein the chamber is enclosed on all sides.
18. An assembly of membrane modules according to any one of claims 12 to 17 wherein the header or headers are mounted in a clover shaped manifold.
- 5 19. An assembly of membrane modules according to any one of claims 12 to 17 wherein the header or headers are mounted in a linear, rectangular, square, or hexagonal manifold.
20. An assembly of membrane modules according to any one of claims 12 to 19 wherein the chamber has a plurality of sides positioned to form a skirt directly beneath a
10 header or plurality of headers
21. An assembly of membrane modules according to any one of claims 12 to 20 when arranged in the form of an extended linear array wherein the chamber has enclosed long sides.
22. An assembly of membrane modules according to any one of claims 12 to 21 in the
15 form of an extended linear array wherein the chamber has unenclosed short sides.
23. A method of removing a fouling material from a plurality of porous hollow fiber membranes mounted and extending longitudinally in an array to form a membrane module, the method comprising the steps of:
- providing a source of gas to a chamber in fluid communication with said membrane
20 module;
- flowing the gas from the chamber into a base of the membrane module to form gas bubbles therein when said module is immersed in a liquid, whereby an upward flow of the gas bubbles across surfaces of the hollow fiber membranes is obtained, and whereby fouling materials are dislodged from the surfaces of the porous hollow fiber membranes.

24. A method according to claim 23 wherein the source of gas to the chamber is provided within the chamber.
25. A method according to claim 23 wherein the source of gas to the chamber is provided from below the chamber.
- 5 26. A method according to claim 23 wherein said chamber is elongate with one end open and the other end in fluid communication with the membrane module.
27. A method according to claim 26 wherein the gas is provided through the open end of the chamber.
28. A method of removing a fouling material from a plurality of porous hollow fiber
10 membranes mounted and extending longitudinally in an array to form a membrane module, the method comprising the steps of:
forming a mixture of gas bubbles and liquid within a mixing chamber;
injecting the mixture into a base of the membrane module, whereby an upward flow of the mixture across surfaces of the hollow fiber membranes is obtained, and whereby fouling
15 materials are dislodged from the surfaces of the porous hollow fiber membranes.
29. A method according to claim 28 wherein the step of forming a mixture includes entraining the gas bubbles into a liquid stream.
- 30 A method according to claim 29 wherein the gas bubbles are entrained into said liquid stream by means of the chamber.
- 20 31. A method according to claim 29 wherein the gas bubbles are entrained or injected into said liquid stream by means of devices which forcibly mix gas into a liquid flow to produce a mixture of liquid and bubbles.
32. A method according to any one of claims 23 to 31 wherein air entering the mixing chamber is deflected.
- 25 33. A method according to claim 32 wherein air entering the mixing chamber is deflected

by way of a T-piece or baffle.

34. A method according to claim 32 or 33 wherein air entering the mixing chamber is deflected away from liquid entering the mixing chamber by way of a nozzle.

35. A membrane module comprising a plurality of porous membranes, said membranes
5 being arranged in close proximity to one another, a mixing chamber in fluid communication with said module for mixing together liquid and gas bubbles to provide a cleaning mixture and means for flowing said cleaning mixture along the surface of said membranes to dislodge fouling materials therefrom.

36. A method of removing fouling materials from the surface of a plurality of porous
10 hollow fibre membranes mounted and extending longitudinally in an array to form a membrane module, said membranes being arranged in close proximity to one another, the method comprising the steps of forming a mixture of gas bubbles and liquid within a mixing chamber, said mixture being formed by said gas bubbles being entrained in said liquid by flowing said liquid past a source of gas so as to cause said gas to be drawn and/or
15 mixed into said liquid, flowing said mixture into said membrane module such that said bubbles pass substantially uniformly between each membrane in said array to, in combination with said liquid flow, scour the surface of said membranes and remove accumulated solids from within the membrane module.

37. A method according to claim 36 wherein the membranes comprise porous hollow
20 fibres, the fibres being fixed at each end in a header, the lower header having one or more holes formed therein through which mixture of gas/liquid is introduced from the mixing chamber.

38. A method according to claim 37 wherein the holes are circular, elliptical or in the form of a slot.

25 39. A method according to claim 36 wherein the membranes comprise porous hollow

fibres, the fibres being fixed at each end in a plurality of headers, the lower headers being configured to provide a number of distribution apertures therebetween through which mixture of gas/liquid is introduced from the mixing chamber.

40. A membrane module for use in a membrane bioreactor including a plurality of
5 porous hollow membrane fibres extending longitudinally between and mounted at each end to a respective potting head, said membrane fibres being arranged in close proximity to one another, said fibres being partitioned into a number of bundles at least at or adjacent to their respective potting head so as to form a space therebetween, a mixing chamber connected or open to a source of gas and liquid, one of said potting heads having an array
10 of openings formed therein in fluid communication with said chamber for providing gas bubbles within said module such that, in use, said bubbles move past the surfaces of said membrane fibres to dislodge fouling materials therefrom.

41. An assembly of membrane modules for use in a membrane bioreactor including a plurality of porous hollow membrane fibres extending longitudinally between and mounted
15 at each end to a plurality of respective potting heads, said membrane fibres being arranged in close proximity to one another, said fibres being partitioned into a number of bundles at least at or adjacent to their respective potting head so as to form a space therebetween, a mixing chamber connected or open to a source of gas and liquid, said potting heads being configured to provide a number of distribution apertures therebetween in fluid
20 communication with said chamber for providing gas bubbles within said assembly of membrane modules such that, in use, said bubbles move past the surfaces of said membrane fibres to dislodge fouling materials therefrom.

42. A membrane module or assembly according to claim 40 or claim 41 wherein the liquid used is feed to the membrane module.

25 43. A membrane module or assembly according to any one of claims 40 to 42 wherein

the fibres within the module have a packing density of between about 5 to about 70%.

44 A membrane module or assembly according to claim 43 wherein the packing density is between about 8 to about 55%.

45. A membrane module or assembly according to any one of claims 40 to 44 wherein
5 said holes have a diameter in the range of about 1 to 40 mm.

46. A membrane module or assembly according to claim 45 wherein said holes have a diameter in the range of about 1.5 to about 25 mm.

47. A membrane module or assembly according to any one of claims 40 to 46 including a deflector within said mixing chamber configured to deflect gas away from the source of the
10 liquid.

48. A membrane module or an assembly according to any one of claims 1 to 9, 12 to 22, 35, or 40 to 47 including a nozzle whereby liquid is introduced into the mixing chamber.

49. A membrane bioreactor including a tank having means for the introduction of feed thereto, means for forming activated sludge within said tank, a membrane module or an
15 assembly according to any one of claims 1 to 9, 12 to 22, 35, or 40 to 48 positioned within said tank so as to be immersed in said sludge and said membrane module provided with means for withdrawing filtrate from at least one end of said fibre membranes.

50. A method of operating a membrane bioreactor of the type according to claim 49, comprising introducing feed to said tank, applying a vacuum to said fibres to withdraw
20 filtrate therefrom while periodically or continuously supplying a cleaning mixture of gas bubbles and liquid formed in a mixing chamber through said openings to within said module such that, in use, said cleaning mixtures flows along the surface of said membrane fibres to dislodge fouling materials therefrom.

51. A membrane bioreactor according to claim 49 wherein a further source of aeration
25 is provided within the tank to assist microorganism activity.

52. A membrane bioreactor according to claim 51 wherein the membrane module is suspended vertically within the tank and said further source of aeration is provided beneath the suspended module.

53. A membrane bioreactor according to claim 52 wherein the further source of
5 aeration comprises a group of air permeable tubes.